

What is claimed is:

- 1 1. An accelerometer, comprising:
2 a measurement mass for detecting acceleration, including a
3 housing having a cavity, a spring mass assembly positioned within the cavity,
4 and one or more mass electrodes coupled to the spring mass assembly;
5 a top cap wafer coupled to the measurement mass, including a top
6 capacitor electrode; and
7 a bottom cap wafer coupled to the measurement mass, including
8 a bottom capacitor electrode;
9 wherein the surfaces of one or more of the mass electrodes, the
10 top capacitor electrode, or the bottom capacitor electrode include one or more
11 re-entrant openings.
- 1 2. The accelerometer of claim 1, wherein the re-entrant openings include
2 one or more re-entrant grooves.
- 1 3. The accelerometer of claim 2, wherein the re-entrant grooves are
2 herringbone shaped.
- 1 4. The accelerometer of claim 2, wherein the re-entrant grooves are
2 criss-crossed.
- 1 5. The accelerometer of claim 2, wherein the re-entrant grooves extend from
2 a central location in a radial direction.
- 1 6. The accelerometer of claim 2, wherein the width of the re-entrant grooves
2 increases in the direction of the periphery of the electrodes.
- 1 7. The accelerometer of claim 1, wherein the openings include one or more
2 re-entrant holes.

1 8. The accelerometer of claim 7, wherein the re-entrant holes are connected
2 beneath the surfaces of the electrodes.

1 9. The accelerometer of claim 7, wherein the size of the re-entrant holes
2 increase in the direction of the periphery of the electrodes.

1 10. A method of operating an accelerometer including a measurement mass
2 for detecting acceleration, including a housing having a cavity, a spring mass
3 assembly positioned within the cavity, and one or more mass electrodes coupled
4 to the spring mass assembly, a top cap wafer coupled to the measurement
5 mass, including a top capacitor electrode, and a bottom cap wafer coupled to the
6 measurement mass, including a bottom capacitor electrode, comprising:

7 reducing fluid damping between the electrodes by providing one
8 or more re-entrant openings in the surfaces of one or more of the electrodes.

1 11. The method of claim 10, wherein the re-entrant openings include one or
2 more re-entrant grooves.

1 12. The method of claim 11, wherein the re-entrant grooves are herringbone
2 shaped.

1 13. The method of claim 11, wherein the re-entrant grooves are criss-crossed.

1 14. The method of claim 11, wherein the re-entrant grooves extend from a
2 central location in a radial direction.

1 15. The method of claim 11, wherein the width of the re-entrant grooves
2 increases in the direction of the periphery of the electrodes.

1 16. The method of claim 10, wherein the openings include one or more
2 re-entrant holes.

1 17. The method of claim 16, wherein the re-entrant holes are connected
2 beneath the surfaces of the electrodes.

1 18. The method of claim 16, wherein the size of the re-entrant holes increase
2 in the direction of the periphery of the electrodes.

1 19. A method of forming a re-entrant opening, comprising:
2 providing a substrate;
3 patterning a portion of the substrate to form a cavity having an
4 upper cross sectional area;
5 bonding a wafer having an internal etch-stop layer onto the surface
6 of the substrate;
7 etching the wafer down to the etch-stop layer; and
8 patterning the wafer to form an opening that exposes the cavity;
9 wherein the cross sectional area of the opening is less than the
10 upper cross sectional area of the cavity.

1 20. The method of claim 19, further including:
2 removing the etch-stop layer.

1 21. A method of forming a re-entrant opening, comprising:
2 providing a silicon substrate;
3 depositing a layer of silicon dioxide onto the silicon substrate;
4 patterning the layer of silicon dioxide;
5 depositing a layer of silicon onto the layer of silicon dioxide and the
6 exposed portions of the silicon substrate;
7 patterning the layer of silicon to form an opening that exposes the layer
8 of silicon dioxide; and

9 removing the layer of silicon dioxide.

1 22. The method of claim 21, wherein patterning the layer of silicon includes:
2 patterning the layer of silicon to form a plurality of openings that expose
3 the layer of silicon dioxide.

1 23. A method of forming a re-entrant opening, comprising:
2 providing a substrate;
3 depositing a layer of a masking material onto the substrate;
4 patterning the masking material to form an opening;
5 etching the exposed portions of the substrate to form a re-entrant
6 opening.

1 24. The method of claim 23, wherein the re-entrant opening comprises a
2 re-entrant groove.

1 25. A method of forming a re-entrant opening, comprising:
2 providing a substrate;
3 depositing a first layer of a masking material onto the substrate;
4 patterning the layer of masking material to form an opening;
5 etching the exposed portions of the silicon substrate to form a channel;
6 depositing a second layer of a masking material onto the exposed
7 portions of the substrate;
8 patterning the second layer of masking material to form an opening; and
9 etching the exposed portions of the silicon substrate to form a re-entrant
10 opening.

1 26. The method of claim 25, wherein the re-entrant opening comprises a
2 re-entrant groove.

- 1 33. The method of claim 32, wherein the grooves are herringbone shaped.
- 1 34. The method of claim 32, wherein the grooves are criss-crossed.
- 1 35. The method of claim 32, wherein the re-entrant grooves extend from a
2 central location in a radial direction.
- 1 36. The method of claim 32, wherein the width of the grooves increases in the
2 direction of the periphery of the electrodes.